supporting Indigenous students' achievement in numeracy

DIANNE SIEMON (RMIT University), FRAN ENILANE and JAN McCARTHY (NT DEET) **report on the state project designed to explore numeracy outcomes of Indigenous students. The project was conceptualised by the Northern Territory Department of Employment, Education and Training, the Catholic Education Office, Darwin and the Association of Independent Schools of the Northern Territory.**

In recognition of the particular needs of Indigenous students living in remote communities, Education authorities in the Northern Territory commissioned the *Supporting Indigenous students achievement in numeracy* project (2003–2004) to explore the potential of authentic (rich) assessment tasks to improve the numeracy outcomes of middle years Indigenous students. The Australian Government Department of Education, Science and Training funded the project as part of the Government's *Numeracy Research and Development Initiative* in December 2002. The project was aimed at researching the impact of the development and implementation of authentic (rich) assessment tasks on the numeracy outcomes of middle years Indigenous students in a targeted group of remote, non-urban schools. The *National Numeracy Benchmarks for Years 3, 5 and 7* (MCEETYA, 2000) and the *NT Curriculum Framework, EsseNTial Learnings* (NT DEET, 2001) were used to frame what was meant by numeracy outcomes in this context. At the outset, an assessment task was regarded as authentic (rich) if it connected to some aspect of the students' experience, allowed all students to make a start, supported a range of different solution strategies and/or correct responses, and had the potential to reveal something of the students' mathematical thinking (see Clarke & Clarke, 1998).

From February 2003 to April 2004, the Project Officer and the consultant worked with the relevant teachers and teacher assistants from two trial schools, four research schools and a Darwin-based independent school that has a relatively large number of Indigenous students from remote communities. The project involved the schools in trialing and/or implementing a range of rich tasks aimed at identifying starting points for numeracy teaching. Given the time frame of the project and the relatively small sample size, most of the tasks were adapted from ones that had been used successfully in related research projects (e.g., the Tasmanian *Improving numeracy for Indigenous students in secondary schools* project

1999–2001 and the Victorian *Middle years numeracy research project* 1999–2001). Participating teachers were asked to reflect on the use of the tasks and provide feedback in the form of written reports or journal entries. The tasks were revised over the course of the project on the basis of this feedback, and advice from research school teachers and 'expert others' with extensive experience in remote communities. Detailed task advice was prepared to help teachers scaffold the use of the tasks for students with little or no access to English and to assist teachers interpret student responses.

To evaluate the impact of using rich tasks on Indigenous student numeracy outcomes, in particular to evaluate the efficacy of more targeted teaching, student numeracy was assessed in May–June 2003 and again in March–April 2004 using an extended rich task and a small number of shorter rich tasks. An example of one of the tasks, together with its associated scoring rubric, is shown in Figure 1. On each occasion, student responses were scored by the teachers using the scoring rubrics and analysed by the research team using item response theory (Bond & Fox, 2001).

The experience of the first round of teaching prompted research school teachers to identify number as the area on which they would focus in the following phase of the project. Teachers and schools were supported through targeted professional development, and the provision of a numeracy kit which included a number of current teacher reference books and a CD-ROM of selected Maths300 lessons. The researcher and project officer visited schools and classrooms during this phase to support and model a wider range of teaching and learning strategies in relation to number.

It was decided that a more detailed evaluation of individual student learning needs in relation to number was required, as the tasks used in the initial round of testing were aimed more generally at numeracy and not all tasks were accessed by all students. To this end, a series of probe tasks, originally developed to support teacher education at RMIT University, were trialled by the project teachers and teacher assistants. The tasks were felt to be appropriate as they addressed key number concepts and/or strategies, were relatively short and easy to administer, utilised cards and/or concrete materials, and generally required non-written responses. However, while the probe tasks typically allowed all students to make a start and revealed something of the students' thinking, they could not be described as authentic or rich tasks in the sense that this is usually understood. The probe tasks were drawn from published research that identified different levels of understanding based on qualitatively different responses offered by students. Many of these same tasks (or variations of these) are included in systemic interview protocols such as *Count me in too* (New South Wales) and the *Early numeracy interview* (Victoria). As responses could be more readily observed and matched to the expected levels of performance, they generally provided a much better indication of student learning needs than was the case with the authentic (rich) tasks used in the first round of testing in the research schools. An example of a probe task is given in Figure 2.

A *probe task manual* was prepared to help teachers scaffold each task, interpret student responses and plan a targeted teaching response. The advice for the *Beginning partitioning probe task* is provided in Figure 3.

FISHY BUSINESS

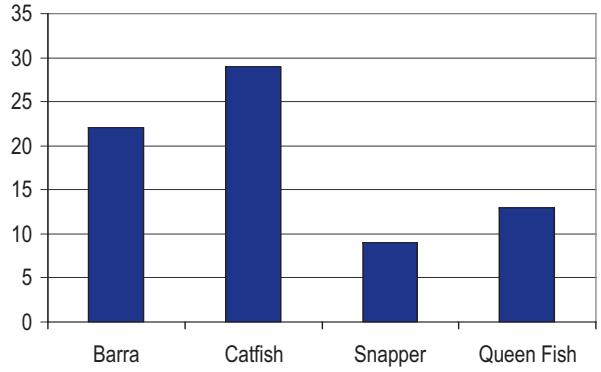
Two classes went fishing on a school excursion.

Each class caught some fish.

There were 73 fish caught altogether.

(a) How many might each class have caught?

(b) Back at school, the teachers asked the children to count all the different kinds of fish and to make a graph



What does the graph show you?

Write as many things as you can.

Scoring rubric used with Fishy Business

(a)	No response or response irrelevant, appears to be random.	0
	Numbers chosen indicate question has been understood, but numbers do not sum to 73 (e.g., 23 and 40).	1
	Numbers chosen add to 73 but make little sense in context (e.g., 70 and 3).	2
	Numbers chosen sum to 73 and are plausible (at least 20 items).	3
(b)	No response.	0
	At least one fairly straightforward observation; e.g.: 'The most fish were catfish, then more catfish than anything else'; 'About 20 barramundi were caught'.	1
	One or more higher order comparisons or observations; e.g.: 'Most fish caught were catfish, then barra, then queen fish, then snapper'. Or approximate quantities stated for two or more items; e.g.: 'About 30 catfish and 10 snapper were collected'. Little/no prompting required.	2
	One or more higher order comparisons or observations, and very good approximations are given for two or more categories of fish.	3

Figure 1

BEGINNING PARTITIONING PROBE TASK

You will need:

- A 1 metre length of rope (not too thick). Some pegs (or blue-tak as required)
- Cards (8 quarter A4 size cards with numbers 0, 100, 48, 67, 26, 20, 8 and 16)

Stretch out rope in front of the student (anchor ends if necessary) and say, 'Let's imagine all of the numbers from 0 to 100 are on this rope'. As you say this, peg the '0' card at the beginning of the rope and the '100' card at the end of the rope.

Place the '48' card in front of the student and say, 'Can you peg this card on to the rope to show where you think that number would be? Can you tell me why you put it there?'

Note where the card is placed and student's response/strategies.

Repeat with the '67' and '26' card. Note responses and strategies

If hesitant or unable to proceed at any point, remove the '100' card and replace by the '20' card. Say, 'Okay, now let's imagine all of the numbers from 0 to 20 are on this rope.'

Place the '8' card in front of the student and say, 'Can you peg this card on to the rope to show where you think that number would be? Can you tell me why you put it there?'

Note student's response/strategies.

If done reasonably well, place '16' card in front of student and ask them to peg that on the rope as well. Note student's strategies.

Figure 2

Results and outcomes

While the results of the first and second rounds of testing indicate an overall improvement in numeracy outcomes for the students who completed both tests, it was clear from the data, teacher reports and field observations that students in the target group found the 'rich' tasks difficult to access even though a concerted attempt had been made to ensure that the tasks were relevant and the literacy demands were kept to a minimum. It was also evident that there was considerable variation in task administration both within and between schools. For example, access to first language speakers was not always possible so that responses were limited to what the students could write or explain in English. This has important implications for the wider use of these types of tasks and suggests that much more work is needed to ensure equity of access across very different communities. The experience of the project has shown that this is a significant and non-trivial task that requires considerable effort and the sustained involvement of Indigenous and non-Indigenous teachers, schools and community leaders over an extended period of time.

Observations and feedback also suggest that research school teachers felt more comfortable and confident with implementing the probe tasks than the rich tasks. The probe tasks were seen to be easier to use as they were less dependent

BEGINNING PARTITIONING

This task should only be used where students have demonstrated a good grasp of 2-digit place-value and have some appreciation of halving. Student responses to this task indicate the extent to which students can locate a 2-digit number in relation to a given range of numbers. This is an important aspect of number sense (proportion) and underpins later work with division and fractions.

Partitioning at this level is a form of visual division. In this case, it is evident if students use their knowledge of halves and halving to make an informed (usually reasonably accurate) judgement about where to locate 48 ('It's about half') and 26 (It's just a bit more than a quarter'). For 67, students may know that this 'is about 2 thirds', but they are more likely to reason on the basis of what they know about halves and quarters in relation to 100, e.g., 'it's between a 50 and 75 but closer to 75'.

Observed response	Interpretation/ Suggested teaching response
Some difficulty locating numbers larger than 20 but reasonable attempt for numbers less than 20 on 0 to 20 line, may attempt to locate or justify placements by counting intervals from 0 using card width as a measure	Suggests numbers beyond 20 not well understood in terms of relative magnitude, possibly seen only as count of ones • Consolidate 2-digit place-value by making, naming, recording, comparing, etc. (see above) • Model and practice ordering and sequencing 2-digit numbers, e.g., Place-Value Game.
Numbers larger than 20 placed more or less correctly, but actions and/or reasons given suggest counting rather than halving or partitioning strategies	Suggests numbers understood additively, that is, as a combination of tens and ones, may not see interval marked by 0 to 100 as something that can be partitioned to locate numbers • Review and discuss every-day halving, e.g., halving an orange, a length of paper tape, a piece of paper etc • Review doubling and halving, discuss numbers in terms of their relationship to other numbers, e.g., 10 is half of 20, 30 is half of 60 and so on
Cards placed fairly accurately with relatively little hesitation, explanations based on partitioning, e.g., halving and/or fraction fact knowledge	Suggests sound knowledge of relative magnitude of 2-digit numbers in relation to 100 and basic fraction fact knowledge of halves and halving • Make the halving strategy more explicit by using a range of materials such as coloured square paper, paper streamers, counters etc and discussing the implications of successive halving • Consider introducing the thirding and fifthing partitioning strategies.

Figure 3

on English language teaching, used more concrete materials and manipulatives, and expanded teachers' own understanding of teaching and learning mathematics. Teachers also reported that they could follow the instructions clearly and were able to observe and record the strategies students used. For example,

> Using the probe tasks with the students has given me the opportunity to identify the concepts that need to be taught. So I have began to put together a series of activities that can be used to teach and reinforce concepts at the various levels. I have used activities out of the *Developing Efficient Numeracy Strategies Stage 2* as well as one I have used before or have found. I am planning to undertake together at least four activities at each level for each concept, along with the required equipment. (HB, October 2003)

> Through our previous discussions relating to the response of the students and teachers to the first round of assessment tasks, you are aware of our strong concern that the materials, although good in themselves were too language based to be effective in this context. With the development of the probe tasks, however, our concerns have definitely abated! Frustration has turned to confidence and empowerment. Through the effective process of you modelling the probe tasks to each teacher, using a child from the classroom, a vision of achievable results began to emerge. For the first time in this ESL Indigenous context, it provides the opportunity to galvanise teachers to realistically integrate 'number sense' into our whole-school planning process. (SP, October 2003)

> The project has had an impact on the whole school. Teachers were struggling silently with the teaching of mathematics. Through the project, teachers are now talking and sharing ideas. People are interested in learning more. Teachers are talking/sharing about what they are doing with the probes and teaching number at meeting. (TC, October 2003)

Related to this, and an extremely important outcome of the project, is the reported growth in teacher knowledge and confidence about how to teach mathematics more effectively to students in remote, non-urban communities. For many, the experience of the project has challenged their view of school mathematics and made them more aware not only of the importance of core mathematical knowledge but also of the need for students to be able to interpret and apply this knowledge in unfamiliar contexts to achieve some purpose and communicate their thinking in ways that others can understand and discuss. This is an important goal of numeracy programs everywhere and represents an important first step in improving the numeracy outcomes of Indigenous students living in remote communities.

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